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THE EFFECT OF SELECTED FACTORS ON THE GROWTH ABILITY OF CHAROLAIS CATTLE

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Abstract

TOUŠOVÁ RENATA, DUCHÁČEK JAROMÍR, STÁDNÍK LUDĚK, PTÁČEK MARTIN, BERAN JAN. 2014. The Effect of Selected Factors on the Growth Ability of Charolais Cattle. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 62(1): 255–260.

The aim of this work was to analyze the growth abilities of bull and heifer calves (n = 190) of the Charolais breed calved in one herd from 2006 to 2011. The evaluation was carried out during the period of calf raising, focusing to the effects of sex, parity and the mating method on live birth weight (BLW) and the live weight at 120 (LW120), 210 (LW210) and 365 (LW365) days of life, as well as the average daily weight gain reached by the age of 120 (G120), 210 (G210), and 365 (G365) days. Statistical analysis was carried out with the use of the SAS 9.3 program. The effect of sex on the live weight and average daily weight gain was statistically significant on the level of $P < 0.01$ always in favour of the bull calves (BLW +3.05 kg, LW120 +29.35 kg, LW210 +36.98 kg, and LW365 +117.23 kg). The lowest live birth weight was detected in the calves of primiparous cows (BLW = 45.46 kg; $P < 0.01$). The higher parity, the higher live birth weight was determined, with maximum values in cows from the fourth calving. The trends were similar in live weight at 120, 210 and 365 days of age, when significance level was $P < 0.05$. The parity effect on the average daily weight gain (G120, G210 a G365) was statistically insignificant ($P > 0.05$). The effect of embryo transfer (ET) and other commonly used reproduction methods (insemination and natural mating, AI/PP) was evaluated as well as. The calves born after embryo transfer showed a significantly ($P < 0.01$) higher the live birth weight as well as weight at different ages (BLW +5.85 kg, LW120 +18.15 kg, LW210 +22.94 kg and LW365 +35.43 kg), and G120 only (+100 g×day^{-1}; $P < 0.05$). These results pointed the suitability of using the biotechnological reproduction methods, especially in relation to the total weight of the reared and fattened animals.

Keywords: beef cattle, growth, sex, breeding, embryo transfer

INTRODUCTION

Growth ability belongs among the most important parameters concerning the production of beef (Sturaro *et al.*, 2005). Live weight as a growth parameter is evaluated in calves' 120, 210 and 365 days of age in the Czech Republic (Voříšková *et al.*, 2010). The most important weight, affecting the calves marketability and overall breeding economy, is the live weight reached at 210 days of age (age of weaning). The growth of calves and their weaning weight is influenced by a number of factors, e.g. genotype as well as individual (Jakubec *et al.*, 2003; Ducháček *et al.*, 2011), the dam age (Roffeis and Muench, 2007), the sex of calves (Stádník *et al.*, 2008), the occurrence of twins (Krupa *et al.*, 2005), the year and period of calving (Dadi *et al.*, 2002), difficulty of calving (Eriksson *et al.*, 2004), nutrition, and others (Zahrádková *et al.*, 2010). According to Szabó *et al.* (2006), growth shows a low level of heritability (h^2 = 0.12–0.27) and the growth ability is affected mainly by the number of calvings of the cow – i.e. parity, correlated to the body development and reaching physical maturity, to the difficulty of calving, and to the maternal properties (such as milkiness). The relationship between calving difficulty, parity and the calves' weight during rearing was also explored by Krupa *et al.* (2005). These authors also confirmed that the live birth weight and the sex of the calf significantly influenced the occurrence of difficult calvings in primiparous. Live birth weight is a parameter

affecting the course of calving up to 71% cases in the first parity and 61% in the second parity, which represents one of the basic selection criteria.

It is possible to use either natural mating or the method of artificial insemination in the suckler herds. Insemination allows for a better bull selection and therefore leads to an increase in the growth abilities of calves, especially the bull calves (Berry and Cromie, 2007). Embryo transfer is another method which can be used in the breeding of beef cattle. Although this method of breeding uses up a larger number of insemination doses, only the best bulls are used. The main advantages of this method are a shorter generation interval and faster as well as wider usage of the desired genotypes (Burdych *et al.*, 2004). According to Villanueva *et al.* (1995), the method of embryo transfer brings up to 30% higher genetic progress compared with the normal methods of breeding, however due to its higher labour and financial demands it is used only sparingly. That is the reason why the main aim of this study was to evaluate the live birth weight and weight at the age of 120, 210, and 365 days, and daily weight gain at 120, 210, and 365 days of the Charolais calves during rearing period, based on the selected factors, with an emphasis on the influence of embryo transfer.

MATERIAL AND METHODS

The monitoring included the total number of 190 Charolais calves. The evaluation included 98 bull calves and 92 heifer calves born at one herd between the years 2006–2011. The system of mating in the monitored herd included the methods of embryo transfer, insemination and natural mating. Both groups of cows, donors as well as recipients, used for embryo transfer were the Charolais breed. The calving period took place between November and April. All animals had access to the pasture during the grazing period of May to October. The calves remained with the cows until the end of the grazing period. All of the animals were housed together in the wintering blocks at the end of the grazing period. The rations during this time were based on silages with higher content of dry matter, hay, and straw. All animals were fed *ad libitum*. In accordance with the methodology of performance recording for cattle without market milk production (Kvapilík *et al.*, 2013) the study monitored the live birth weight (BLW) and the weight at 120 (LW120), 210 (LW210), and 365 (LW365) days of age. Based on the obtained live weight measurements, daily weight gains were calculated for the time periods from birth to 120 (G120), 210 (G210), and 365 (G365) days of age, according to the following formula:

$$G = (LW - BLW)/120;210 \text{ or } 365.$$

Statistical software SAS 9.3 (SAS, 2011) was used to analyze the results. The UNIVARIATE procedure was applied for descriptive statistics determination. In order to evaluate the relationship between the variables (growth ability parameters, number and difficulty of the calvings), the CORR procedure was used. The final analysis was carried out with the MIXED procedure. Akaike Information Criterion was used for the best model determination. The above mentioned growth ability parameters were evaluated based on the relationship to: year of birth, calving difficulty, sex of the calf, parity and the method of mating,. The mixed model equation used for the evaluation was as follows:

$$Y_{ijklmn} = \mu + CB_i + CD_j + SEX_k + OC_l + ET_m + e_{ijklmn},$$

where:

Y_{ijklmn} ..dependent variable (BLW, LW120, LW210, LW365, G120, G210, G365);

μ.....mean value of dependent variable;

CB_i.....fixed effect of i^{th} year of birth (i = 1 –2006/2007, n = 35; 2 –2007/ 2008, n = 36; 3 –2008/2009, n = 44; 4 –2009/2010, n = 36; 5 –2010/2011, n = 39);

CD_j.....fixed effect of j^{th} calving difficulty (j = 1 – easy calving, n = 98; 2 calving with a little help, n = 76; 3 difficult calving, n = 16);

SEX_k...fixed effect of k^{th} sex of calf (k = bull, n = 98; heifer, n = 92);

OC_l.....fixed effect of l^{th} cows parity (l = the 1^{st} parity, n = 77; the 2^{nd} parity, n = 34; the 3^{rd} parity, n = 27; the 4^{th} parity, n = 17; the 5^{th} and subsequent parity, n = 35);

ET_m.....fixed effect of m^{th} method of mating (m = embryotransfer, n = 42; natural breeding and insemination, n = 148);

e_{ijklmn} ...random error.

Significance levels $P < 0.05$ and $P < 0.01$ were used to evaluate the differences between groups.

RESULTS AND DISCUSSION

The average live birth weight (BLW) was 46.9 kg, live weight at 120 days (LW120) was 191.3 kg, live weight at 210 days (LW210) 310.7 kg and the live weight at 365 (LW365) days of age was 496.5 kg. The average daily weight gains during rearing were as follows: daily weight gain at 120 days (G120) was 1203 g*day^{-1}, at 210 days (G210) 1313 g*day^{-1} and at 365 days (G365) 1192 g*day^{-1}.

Tab. I shows Pearson's correlation coefficients for the growth performance of all the evaluated calves. The live birth weight was significantly ($P < 0.001$) correlated with all the other remaining monitored live weights (LW120, r = 0.369; LW210, r = 0.391; LW365, r = 0.495), as well as G365 (r = 0.392), parity (r = 0.216) and the difficulty of calving (r = 0.341). Similar correlation coefficients values between BLW and LW120, resp. LW210 were also determined by Vostrý *et al.* (2012). LW120 was also significantly related to all of the other evaluated live weights (LW210, LW365) and daily weight gains (G120, G210, G365) (r = 0.203 – 0.961, $P < 0.01 – 0.05$). There were also conclusive relationships determined between

I: *Correlations among the selected indicators of growth ability*

		LW120	LW210	LW365	G120	G210	G365	parity	calving difficulty
BLW	**r**	0.369	0.391	0.495	0.098	0.148	0.392	0.216	0.341
	P	< 0.001	< 0.001	< 0.001	0.209	0.064	< 0.001	0.003	< 0.001
LW120	**r**		0.842	0.727	0.961	0.203	0.444	0.040	0.092
	P		< 0.001	< 0.001	< 0.001	0.011	< 0.001	0.610	0.239
LW210	**r**			0.785	0.797	0.700	0.486	–0.001	0.127
	P			< 0.001	< 0.001	< 0.001	< 0.001	0.993	0.114
LW365	**r**				0.655	0.439	0.833	0.109	0.174
	P				< 0.001	< 0.001	< 0.001	0.200	0.041
G120	**r**					0.175	0.371	–0.035	0.007
	P					0.028	< 0.001	0.658	0.933
G210	**r**						0.198	–0.094	0.085
	P						0.020	0.241	0.2919
G365	**r**							0.091	0.170
	P							0.287	0.046
parity	**r**								–0.125
	P								0.078

II: *Basic characteristics of the model equation used for data analysis*

Traits	MODEL		year of birth		calving difficulty		sex		parity		mating	
	r^2	P	F-test	P	F-test	P	F-test	P	F-test	P	F-test	P
BLW	0.387	< 0.001	5.19	0.001	20.55	< 0.001	10.23	0.002	11.63	< 0.001	14.92	< 0.001
LW120	0.372	< 0.001	1.34	0.259	0.1	0.907	68.75	< 0.001	3.01	0.02	10.46	0.002
LW210	0.35	< 0.001	1.82	0.128	1.72	0.183	56.23	< 0.001	2.59	0.039	8.32	0.005
LW365	0.64	< 0.001	2.58	0.041	3.88	0.023	178.58	< 0.001	3.67	0.007	6.86	0.01
G120	0.318	< 0.001	0.56	0.689	1.28	0.28	58.52	< 0.001	0.58	0.494	4.84	0.029
G210	0.14	< 0.001	1.34	0.258	1.93	0.149	6.96	0.009	1.67	0.16	0.25	0.615
G365	0.483	< 0.001	1.4	0.237	3.44	0.035	91.84	< 0.001	1.26	0.289	1.29	0.259

BLW – birth live weight; LW120, LW210, LW 365 – live weigh at 120, 210, and 365 days of age; G120, G210, G365 – daily weight gain from birth to 120, to 210, and to 365 days of age.

the other live weights and daily weight gains (r = 0.175 – 0.797, P < 0.05 – 0.01). Low correlations (r = 0.174 resp. 0.170, P < 0.05) were also found between LW365 (G365) and the difficulty of calving. These results are in accordance with the works of Phocast and Sapa (2004), who calculated conclusive genetic correlations between the difficulty of calving and subsequent growth of the reared calves. Other relationships between the variables were statistically insignificant (P > 0.05).

Tab. II shows the basic statistics of the used model equation. The model was statistically conclusive (P<0.001) for all of the evaluated growth parameters. The determination coefficient of the used linear model ranged from $r^2 = 0.140$ for G210 to $r^2 = 0.640$ for LW365. The effects of difficulty of calving and year of birth were statistically significant only for the BLW and LW365 (P < 0.05 – 0.01). BLW is one of the crucial factors affecting the difficulty of calving in beef cattle, as confirmed also by Eriksson *et al.* (2004). On the other hand, higher BLW is also linked to higher calf growth abilities (Koch *et al.*, 2004), which supports the conclusiveness of this effect on LW365. Only the effect of sex was statistically significant for all of the evaluated growth ability parameters (P<0.01). The effect of parity was statistically conclusive only for the BLW, LW120, LW210, and LW365 (P < 0.05). This fact and the effect of sex were also confirmed by Goyache *et al.* (2003). The mating was proved to have a statistically significant effect on all of the evaluated live weights (BLW, LW120, LW210, and LW365) (P < 0.01) however G120 only (P < 0.05).

The evaluation of the calf growth ability itself took into account the effects of year of birth, the mating method, the parity, the difficulty of calving, and the sex of the calf. No clear tendencies were observed for the effect of the birth year. Concerning the effect of difficulty of calving, the conclusive differences were found only in BLW, when occurrence of the heaviest calves (54.93 kg) corresponded to the most difficult calvings. However, both effects did have a positive influence on the quality of the model equation and its repeatability value.

Tab. III shows the statistical analysis resulting from the MIXED procedure, applied to the effects of sex, parity and mating method. Regarding the effect of sex, bull calves reached statistically conclusively ($P < 0.01$) higher values in all of the growth parameters (BLW +3.05 kg, LW120 +29.25 kg, LW210 +36.98 kg, LW365 +117.23 kg, G120 +220 g*day^{-1}, G210 +110 g*day^{-1} a G365 +490 g*day^{-1}). Higher BLW values recorded for the Charolais breed were also reported by Čepon *et al.* (2008). Statistically significant ($P < 0.05 – 0.01$) higher growth abilities expressed by LW120-LW365 and G120-G365 of bull calves were also confirmed by Krupa *et al.* (2005) and Toušová *et al.* (2009).

The results of the performance recording regarding the Charolais breed in 2011 informed that growth parameters of the bull calves were unequivocally higher than the ones recorded in heifers (live birth weight of bull calves 43.1 kg, at 120 days of age 180 kg, and at 210 days of age 290 kg). While the average live birth weight of heifer calves was 40 kg, at 120 days 170 kg and at 210 days of age 250 kg (Kvapilík *et al.*, 2013). It is important to emphasise that although the bull calves reached higher weight values, the heifer calves showed good growth abilities as well. In addition to that, the fattening of heifers could represent a more perspective direction, considering that only a few breeders are dedicated to fattening of this category and slaughter heifers are generally considered to be more of a waste (Šeba, 2013). As Hanzelková *et al.* (2011) documented, heifer calves also show a better beef quality, especially tenderness.

Concerning the parity effect there was a marked increase in the BLW, LW120, LW210, LW365, G120, G210, and G365 observed, continuing by the 4th calving. There were statistically significant ($P < 0.05 – 0.01$) differences calculated for the values of BLW, LW120, and LW365, mainly between the cows after the first and fourth calving. No statistically significant ($P > 0.05$) differences were found between the daily weight gains (G120, G210, and G365) and for the LW210 in cows with different parity. Different live birth weight between the calves of primiparous (39 kg) and cows with higher parity (44 kg) were also reported by Krupa *et al.* (2005). The same tendencies for the results of LW120 and LW210 were observed i by Stádník *et al.* (2008), who reported daily weight gain of +11.45 kg, resp. 20.61 kg in cows with the fourth calving compared with primiparous. The increase of growth parameters was also mentioned in relation to the age or parity of the cow in the studies published by MacGregor and Casey (2000) and Toušová *et al.* (2009). MacGregor and Casey (2000) also inform about higher parity in the local rustic breeds, correlated to the LW210, continuing up to the 9 years of age (+0.86 up to + 10.68 kg). On the other hand, concerning the intensive beef breed Charolais, the highest calculated values of LW120 and LW210 were detected in cows after the third calving (+17.49 kg, +19.71 kg), as reported by Toušová *et al.* (2009). The lowest values were found in the calves born to primiparous cows, which is a result supported by our study as well. This finding confirms the effect of cow parity on the total weight of the fattening animals in the herds of beef cattle. The works of Szabó *et al.* (2006) also informed that the weaning weight of calves had an increasing tendency up to 5 years of cows' age and then tends to decline gradually. The minimal calves' weight recorded by this author was in dams after the second as well as the 12th calving. Considering performance recording of the calves of the Charolais breed, the highest weight of bull calves at 120 days of age (189 kg) was reached in cows above 61 months of age in 2011, while the heifer calves reached weight of 178 kg. The highest recorded weight at 210 days of age (considering cows above 61 months) was also found in bull calves (302 kg), with heifer calves weighing 278 kg (Kvapilík *et al.*, 2013).

Conclusively ($P < 0.01$) higher values of BLW (+5.85 kg), LW120 (+18.15 kg), LW210 (+22.94 kg), and LW365 (+35.43 kg) were observed for the ET method. Better growth ability of young beef cattle born from embryo transfer were also confirmed by the works of Villanueva *et al.* (1995). The effect of

III: *Calves growth abilities evaluation*

Effects	Level	BLW	LW120	LW210	LW365	G120	G210	G365
		LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE	LSM ± SE
sex	b	53.45 ± 0.954^{A}	212.48 ± 3.500^{A}	336.62 ± 4.863^{A}	564.38 ± 8.186^{A}	1.33 ± 0.028^{A}	1.36 ± 0.034^{A}	1.46 ± 0.048^{A}
	j	50.40 ± 0.996^{B}	183.13 ± 3.825^{B}	299.64 ± 5.296^{B}	447.15 ± 9.418^{B}	1.11 ± 0.031^{B}	1.27 ± 0.037^{B}	0.97 ± 0.055^{B}
parity	1	45.46 ± 0.806^{A}	188.26 ± 3.027^{a}	306.31 ± 4.189	477.06 ± 7.072^{a}	1.19 ± 0.025	1.30 ± 0.030	1.10 ± 0.041
	2	50.94 ± 1.388^{B}	192.29 ± 5.381	314.64 ± 7.483	491.67 ± 12.649	1.18 ± 0.044	1.36 ± 0.053	1.23 ± 0.074
	3	54.22 ± 1.521^{B}	202.93 ± 5.577	326.33 ± 7.652	518.94 ± 13.379^{b}	1.24 ± 0.045	1.36 ± 0.054	1.25 ± 0.078
	4	56.23 ± 1.743^{B}	208.55 ± 6.106^{b}	331.03 ± 8.325	527.42 ± 14.850^{b}	1.27 ± 0.050	1.35 ± 0.059	1.26 ± 0.086
	5	52.77 ± 1.368^{B}	197.00 ± 5.076	312.36 ± 7.182	513.73 ± 12.924	1.20 ± 0.041	1.23 ± 0.051	1.23 ± 0.075
mating	ET	54.85 ± 1.426^{A}	206.88 ± 5.349^{A}	329.60 ± 7.526^{A}	523.48 ± 12.872^{A}	1.27 ± 0.043^{a}	1.33 ± 0.053	1.26 ± 0.075
	AI/NB	49.00 ± 0.749^{B}	188.73 ± 2.782^{B}	306.66 ± 3.813^{B}	488.05 ± 6.511^{B}	1.17 ± 0.023^{b}	1.30 ± 0.027	1.17 ± 0.038

BLW – birth live weight; LW120, LW210, LW 365 – live weigh at 120, 210, and 365 days of age; G120, G210, G365 – daily weight gain from birth to 120, to 210, and to 365 days of age; a, b; resp. A, B – different superscript letters confirm statistical significance of difference among within the effect rows at the $P < 0.05$; resp. $P < 0.01$ level.

biotechnological reproduction methods on higher weights of the calves during the rearing period was also recorded by Stádník *et al.* (2008) and Louda *et al.* (2008). Concerning the calculated daily weight gains (G120, G210, and G365) there were also higher values calculated for the calves born from ET (+0.10; +0.03; +0.09 kg). However, statistically significant ($P < 0.05$) difference was determined only for G120. The main contribution of embryo transfer is an improved genetical base reflected in the phenotype of beef cattle mainly by increased growth abilities and shortened fattening period. The serviceability of this method is primarily most suitable for the breeding facilities specialising in the production of genetic material, due to its higher financial demands. However, the method of embryo transfer is unprofitable for the common breeding stations focusing on the breeding of beef cattle in general. The embryo transfer method requires professionally educated, skilled, and materially equipped workers, who are able to secure the transfer with successfulness on the desired level. Embryo transfer has a seasonal character in beef cattle to secure the reproduction in a relatively short time interval (60–90 days). These facts evoke high demands on the breeders and other immediately involved workers. It is necessary to optimalise the breeding conditions in order to secure greatest success as possible. The symbiosis of breeding conditions and a quality of embryo transfer technique predetermines the best results (Říha *et al.*, 1999).

CONCLUSION

The bull calves of the Charolais breed reached higher values of live weight than the heifers of the same breed ($P < 0.01$). The live birth weight of calves (BLW, LW120, LW210, and LW365) increased with higher parity, a trend which continued up to the fourth calving. The results emphasize the importance of longevity of beef cattle, with the Charolais breed being suitable for breeding, at least up until the fourth calving. However, even the fifth and following parities showed higher weight values (BLW, LW120, LW210, LW365) than the first-time heifers and cows with second calvings. An important conclusion is the suitability of the embryo transfer method in order to increase the growth abilities of the calves, which is a result confirmed for the BLW, LW120, LW210, LW365, and G120 parameters on a level of $P < 0.05 – 0.01$. Higher growth abilities of the calves born from embryo transfer can probably also correlated with a potential for better classification of the carcass and its marketability.

SUMMARY

The aim of this work was to analyze the growth abilities of bull and heifer calves of the Charolais breed. The evaluation was carried out during the period of calf raising, based on the selected effects with emphasis on the effects of sex, parity, and the mating method. The study took place between the years 2006–2011, focusing on one suckler herd of cows. The total number of 190 calves was monitored. The study analyzed live birth weight (BLW) and the live weight at 120 (LW120), 210 (LW210), and 365 (LW365) days of life, as well as the average daily weight gain reached by the age of 120 (G120), 210 (G210), and 365 (G365) days. Statistical analysis was carried out with the use of the SAS 9.3 program. The effect of sex on the live weight and average daily weight gain was statistically significant on the level of $P < 0.01$ and was always in favour of the bull calves (BLW +3.05 kg, LW120 +29.35 kg, LW210 +36.98 kg, and LW365 +117.23 kg). The lowest live birth weight was determined in the calves of primiparous cows (BLW = 45.46 kg; $P < 0.01$). Maximum values the live birth weight increased with the increasing parity of calving as well, and was reached in cows after the fourth calving. The situation was similar for the values of live weight at 120, 210, and 365 days of age, only the determined values had a significance level of $P < 0.05$. The parity effect on the average daily weight gain (G120, G210, and G365) was statistically insignificant ($P > 0.05$). The monitored herd was also used in order to evaluate the difference between embryo transfer (ET) and other commonly used reproduction methods (insemination and natural mating). The calves born after embryo transfer showed a significantly ($P < 0.01$) higher live weight recorded at different age stages (BLW +5.85 kg, LW120 +18.15 kg, LW210 +22.94 kg, and LW365 +35.43 kg), as well as G120 (+100 $g*day^{-1}$; $P < 0.05$). Considering the effects of the embryo transfer method, the results showed also higher G210 (+300 $g*day^{-1}$) and G365 (+90 $g*day^{-1}$). The presented results point to the suitability of using the biotechnological reproduction methods, especially from the breeding point of view in relation to the total weight of the born and fattened animals.

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